PROTECTIVE AND SELF-HEALING PROPERTIES OF CERIUM-MODIFIED MOLYBDATE CONVERSION COATING ON STEEL

Aliona Kirdeikienė[1*], Olga Girčienė[1], Laima Gudaviciūtė[1], Vitalija Jasulaitienė[2], Algirdas Selskis[2], Rimantas Ramanauskas[1]

[1] *Department of Chemical Engineering and Technology, State research institute Center for Physical Sciences and Technology, Vilnius, Lithuania*

[2] *Department of Characterization of Materials Structure, State research institute Center for Physical Sciences and Technology, Vilnius, Lithuania*

* *aliona.kirdeikiene@ftmc.lt*

Chromate conversion coatings have been widely applied for corrosion protection of metals, as providing both, barrier and self-healing effects. Due to the legal framework restricting the use of highly toxic Cr (VI) compounds in industry, researchers are looking for alternatives. Phosphating is one of the most widely used passivation treatments of steel, however, the corrosion resistance of the resulting conversion layer is not sufficient and requires to be improved. The protective ability of phosphate coatings on steel could be improved by the passive layer modification with Mo compounds. Meanwhile, additional modification with Ce compounds support the physical barrier on the metal surface and can provide self-healing properties for the resulting coating. The research objects were phosphate/molybdate and cerium-modified phosphate/molybdate conversion coatings deposited on a carbon steel surface [1].

The aim of the present study was to evaluate the protective and self-healing capacities of the deposited conversion coatings on a steel surface and to study the process of a new passive film formation on the artificially damaged areas of these coatings. SEM, TEM, XRD and XPS techniques were applied for the structural, phase and composition characterization of the investigated coatings. Voltammetric measurements were carried out to determine the passive layer protective ability. EIS studies yielded information on the self-healing properties of different protective systems affected by introduced artificial defects.

It was established that the protective properties of the investigated conversion coatings depend on their morphology, microstructure and composition. The presence of sulphate ions in the Ce solution favored the formation of a thinner conversion layer, which had a significantly lower number of structural defects and had the best protective ability among all the investigated coatings. The phosphate/molybdate coatings were shown to be incapable of self-repair. This can be attributed to the fact that molybdates are weaker oxidizing agents than Ce-containing compounds. Among cerium-modified phosphate/molybdate coatings, the one deposited in sulphate containing solution was found to have stronger self-healing ability. This was attributed to the higher total amount of Ce, the larger fraction of Ce (IV) in the conversion coating and the lower number of structural defects. The micro-structural characteristics of protective coatings are also important in determining self-healing abilities, because in assessing active corrosion protection ability of conversion layers it is important to consider not only the ratio of higher and lower oxidation states of the active ions, but also the quantity of material required for self-healing, as this process will occur not only on defected areas, but also in the zones of cracking of the passive conversion film.

References

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